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THE ELECTRIC ENERGY-WATER NEXUS IN ENERGY SECTOR: A LOGISTIC ANALYSIS

PERINI PRAVEENASRI

Associate Professor in Economics, Aksum University, Trigary, Ethiopia

ABSTRACT

Seasonal anomalies in water systems and electricity production are inextricably linked. The study elicits the problem of water scarcity and gauges at the performance of Electric Energy Sector in selected regions of Andhra Pradesh with the aid of empirical methodological approaches. The study evaluates the electric energy efficiency parameters and documents water efficiency management techniques.

***KEYWORDS:** Water Withdrawals, Actual Generation, Condenser Cooling, Seasonal Variation and Cooling Tower*

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INTRODUCTION

Electric Energy production is a vital prerequisite for our economic and social development. The World's entire Electric Energy production is heavily dependent on water. For Example, consider the production of electricity at hydro power sites in which kinetic energy of falling water is converted to electricity. In case of thermal and combined cycle gas based power plants, huge quantities of water is used in boiler for its processing and to drive turbine generators. Apart from this, these power plants require water for thermoelectric cooling process that is imperative to maintain high energy efficiencies. The scope of the study performs an impact assessment of different research studies relating to fresh water shortages in power sector that ushers gainful insights that are imperative for the Electric Energy-Water- Climate seasonal link which makes it essential for adaptation to climate change. It focuses on the ground realities of Fresh water shortages in Electricity Generation Industry at specific state level by quoting real life illustrations. There are incidences of Fresh water Shortages in Electricity Generation Industry at the Global, State and regional level. According to Government Accounting Office (2003), climate variability on water availability have a dramatic impact on water supplies i.e. severe water shortages, with the most obvious impact being drought in 46 states of United States. This drought has made lawmakers in Idaho to rule out, five large coal based and gas-fired power plants. They are denied of water rights for cooling because they would deplete much needed freshwater for drinking and irrigation. Incidents of such kind are many in various other parts of the World that are suffering with this climatic affect on water availability especially in Electricity Generation Industry. Keeping in view of resource crunch, particularly 'Water- as a factor for Electric-Energy crisis' the objective of the study includes first and foremost determining typical water consumption per unit of generation for each power plant by fuel type. The second was to estimate present and future aggregate water availability and loss of generation requirements associated with power plant type. The methodological approaches followed in this study to address the water scarcity problem in power plants includes the three regions of Andhra Pradesh viz; Coastal Andhra Pradesh, Rayalaseema and Telangana are

selected using Water Foot Printing, Seasonal Variation Index.

METHODS

Calculation of Water Foot Printing in Electricity Generation Industry

With the given hard core facts of growing threat of fresh water shortage looms, tracking of water foot prints in Electric- Energy Production Industry is considered as a matter of urgent necessity. According to World Energy Vision Report, 2009 as per International Standards: (Right from mining to End Process) the Water Foot Print--- 2.3 m^3/ MWhr for Low capacity plants and 3.5 m^3/ MWhr - High capacity plants. As a thumb Rule: Thermal Power Plants should record Low WFs and Hydel Power plants should record high WFs. The calculation of water foot print for 1 MW production of electricity is as follows: Sum of total water consumption (i.e. steam generation & DM make up water in boiler + DM plant back wash +Ash slurry + Condenser cooling + Domestic Purpose)

$$\text{Water Foot print} = \frac{\text{Total Water Consumption}}{\text{Generation}}$$

A comparative analysis of water foot prints estimated by feedstock for 10 power plants provides a standard that encompasses a six digit water foot prints in hydel power plants, thermal power plants two and one digit water foot print, natural gas and renewable based electric energy plants recorded one or point wise water foot prints. For instance based on the field level experiences at Srisailam left and Right canal power station the water foot prints computed for the year 2005-06 during summer season stood at 606892.8 m^3/ MWHR that was lowest due to water shortage in comparison with rainy season that recorded a water foot print of 695487.4 m^3/ MWHR. This has been compensated through an open alternate route i.e. pump mode, where in there was quick add to the water foot prints that stood at 3450814.6 m^3/ MWHR. In Narla Tata Rao Thermal power station the water source was from Krishna River. It shows that the water foot prints in summer season were in the range between 78.72 to 120 m^3 /MWhr and in rainy season it was ranging from the level of 77.4 to 153 m3/MWhr. The underlying reason for considerably low level of water footprints in lean season was due to operation of Induced Draft Cooling water technology. For the remaining seasons where there is no induction of cooling technology in some other seasons, the water requirement was high. In case of vijjeswaram natural gas based power plants My Home Power limited revealed an interesting picture, the water foot prints recorded were considerably low at the level ranging from 8.7 m^3/MWH to 0.01 m^3/MWH.

Application of Seasonal Variation Index in Electricity Generation Industry

It is a component of time series which is defined as repetitive and predictable (seasonal changes) around the trend line in one year or less. Electricity Generation Industry affected by seasonal variation (in terms of water availability due to climate variability). Electricity Generation Industry exhibits inquisitiveness in knowing their performance w.r.t. to water withdrawals vis-à-vis power generation relative to normal seasonal variation over a period of month’s i.e., for eg 8 years (2000-2001 to 2008-09) for thermal and hydel power plants. This expects an increase or decrease in power generation both in prospective and lean period of a year. For example in case of Nagarjuna Sagar main power house, Rainy Season: Ranks I: More water withdrawals (WD) – with an index of 152.96, Less loss of generation(LG) - with an index of 127.40 and Summer Season: Ranks III: Less WD- with an index of 90.47 and More LG- with an index of 139.22. For low WD the lowest plant load factor was recorded to the level of 28.96% whereas for high WD the recorded level of PLF Was 42.29%.

Electric Energy Efficiency Strategies: A Technological Breakthrough in NTTPs

For the full-fledged requirement of cooling water for 6 units of NTTPS, the Krishna river level (pond level) should be maintained at 17.2 meters. But keeping in view of water shortage due to fast depletion of pond level in prakasam barrage to the crest level was 13.7 meters during summer season. As a result, when the pond water level is lowered to the crest level in the Prakasam Barrage, water would not flow with the required gravitational force in to the Cooling water canal of the NTTP.

Practical Operational Mode of Induced Draft Cooling Towers

Table 1

Year	Date/Month	River level Depletion/ Excess water Flow	Underlying Reasons
2004	2/May to 26/August	14.0 meters	Apron Inspection and repair works of Irrigation Department of Andhra Pradesh
2005	5/March to 24/ July	< 17.2 meters	Inspection of Apron after floods
2008 2008	18/ June to 26/June 1/September to 5/September	< 17.2 meters < 17.2 meters	Low Fresh Water level in River Krishna
2009 2009	29/August to 10/September 2/October to 3/November	< 17.2 meters <17.2 meters	Low Fresh water level in river due to opening of gates before flood water is reached. Low Fresh Water level due to high discharges from Nagarjuna Sagar, sagardi and canal discharges (Irrigation)

The Alternate Cooling Water System (ACWs) at NTTPS was commissioned on 28-3- 2004. This system comprises of River Water Pump House and Hot Water Pump House. The system consists of: (a) 7 No's River water pumps located at River Water Pump House in Bhavanipuram (6 + 1 No's Pumps). (b) 7 No's Hot water pumps located at Hot Water Pump House in NTTPS Campus (6 + 1 No's pumps)(c) 3 No's Induced Draft counter flow cooling towers with a fill in NTTPS Campus. Each tower is having 12 numbers fans

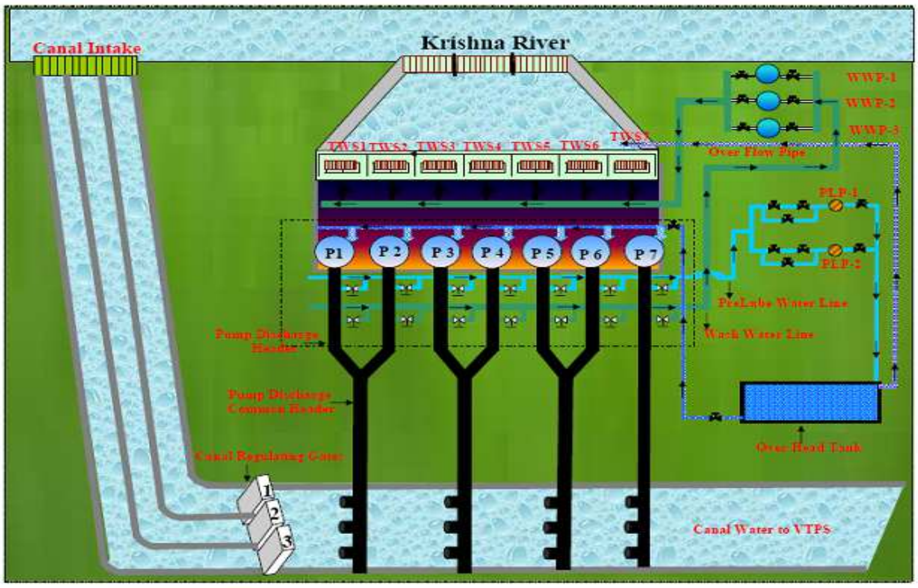

Figure 1: Schematic Representation of River Water Pump House

Finally, the major observation is that out of 365 days in a year, all the six units of NTTPS are functioning as they are now for 320 days of the year. During this period, the water can be drawn in to the CW canal by gravity because of available pond level at 17.39 meters. For the remaining days, i.e. for 45 days during summer there units are availing the facility of cooling towers. The type of cooling towers that used in NTTPS is induced draft. The pumping of 1100 cusecs of water in to CW canal is necessitated during this 45 day period. The power station was able to tackle the problem of water shortage to maximum extent with this cost effective innovative strategy during lean seasons.

POLICY RECOMMENDATIONS

For Judicious Utilization of Water and its conservation in Electricity Generation Industry the following counteracting measures includes

- Afforest ration measures at a massive level can avert the adverse repercussions of climate variability w.r.t to water availability, by onset promotion of abundant water supplies. Usage of Reversible generating sets in Hydel also promotes water conservation
- Cement lining of water canals can avoid shrinkage of water (evaporation losses), there by sustaining the appropriate levels of monsoon water. It is also vital for construction of new dams or artificial ponds timely during rainy season, by not allowing water to get absorbed in to sea. This curbs the wastage of precious water.
- Desalination water technology can be adopted by the selected thermal power plants especially in KTPS O &M, KTPS Stage V and RTPP where in the brackish water from the effluents can be treated for fresh water extraction.
- In dry regions like KTPS and RTPP where there is bountiful availability of natural “sun”, electric energy accessibility can be tapped to the maximum extent. To compensate for the loss of generation due to water shortage, these thermal power plants should set up high capacity solar thermal power integrated with combined system of steam plant as ancillary power industrial units in future. For example in KTPS and RTPP huge pipe lines were laid to pump water from distant place where there is river source, that is not at all cost effective. In regard it is advisable to adapt solar thermal technology that helps to conserve surface water resources.
- Emphasis should be on taking up of renewable energy sources like solar power, wind power and biomass power plants by APGENCO with large installed capacities, instead of relying solely on thermal and hydel stations (that need requisite quantities of water).
- Though our knowledge continues to lay emphasis about climate variability on water availability and vulnerability, we are still far from able to exactly identify the hot spot areas of vulnerability in various power plants of India. In this regard a consistent frame work for vulnerability assessment should be developed. This could serve to identify hot spot areas in power plants on priority basis, where in society, respective power plants and researchers try to either suggest or avert to mitigate climate related risks.
- For enhancement of water resource sustainability in future, a common plat form of multi stake holder that includes stakeholders, civil society, in house power plants, NGOs, Government’s, researchers, scientists etc should be set in for a effective dialogue and discussion on climate variability and necessary steps to be adapted for increasing avenues of water sources.

CONCLUSIONS

The vagaries of monsoonal variability have profound impact on selected Electric Energy Generating power stations. The methodological approaches followed with the statistical application of Seasonal variation Index, Water Foot Printing have elicited the core problem that was apt in the pressing need of the present day hour of Environmental Sustainability. The impartation of technological breakthroughs with can avert the problem of water scarcity to desirable extent.

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